

Comparison of Percutaneous Endoscopic Gastrostomy with Stamm Gastrostomy

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In a review of 125 percutaneous endoscopic gastrostomies (PEG) and 88 Stamm gastrostomies performed at Duke University Medical Center since 1978, the average operating room time for PEG (50 ± 20 min) was shorter than for Stamm (96 ± 26 min) ($p < 0.0001$). General anesthesia was administered in only 13% of PEG placements compared with 64% of Stamm gastrostomies. The cost of PEG was about \$1000 less than for Stamm gastrostomies. The average time after surgery until use of the feeding tube was 1.8 days for PEG compared with 3.4 days for Stamm ($p < 0.0001$). The overall complication rate after PEG was 8.8% (4.0% major) compared with 23.9% for Stamm gastrostomies (10.2% major) ($p < 0.005$). PEG reduces operative time, necessity for general anesthesia, expense of insertion, incidence of complications, and requires less recovery time before use. PEG is the procedure of choice for gastric feeding access.

EGEBERG IS CREDITED WITH first expressing the concept of a gastrostomy in 1837. Sedillott successfully performed gastrostomies in dogs in 1839 but failed in three attempts in humans in 1846 with all three patients dying. It was not until 1876 that Verneuil performed the first successful gastrostomy in humans. Since then, numerous modifications have been suggested including a serosal tunnel by Witzel in 1891, permanent gastrostomy tubes by Janeway and Beck-Jianu in the early 1900s, and a valved gastric tube by Glassman in 1939. The most successful and most commonly used technique today, however, was proposed by Stamm in 1894 using concentric purse string sutures to invaginate the serosa about a tube passed into the stomach. Although relatively simple to perform, the Stamm gastrostomy has been associated with a significant incidence of complications including wound infections, gastric bleeding, skin erosions with leakage about the

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tube, pain at the exit site, anesthetic complications, and occasional death. In an extensive review by Mamel, 264 complications were seen in 1438 Stamm gastrostomy placements (18.4%) with 9.8% of major and 8.7% of minor complications.¹ These complications are due in part to the use of general anesthesia, need for a laparotomy in often malnourished patients, and technical difficulties with placement and securing of the purse string sutures. One publication by Smith and Farris in 1961 is notable for its large number and unusually good experience placing 2512 Stamm gastrostomies with only nine complications (0.4%).²

In 1980, Gauderer et al. described a technique for endoscopic placement of a feeding gastrostomy tube, which could be performed under local anesthesia and did not require a laparotomy.³ In a limited but growing experience, a complication rate one third of that of Stamm gastrostomy has been reported, comprised mainly of tube exit site infections and aspiration pneumonias.^{1,4,5} This review was undertaken at Duke University Medical Center to compare results of percutaneous endoscopic gastrostomy with Stamm gastrostomy with respect to operative time, use of general anesthesia, incidence of complications, time prior to use after placement, and cost.

Methods

The records of all patients who underwent placement of a feeding gastrostomy by the author from November 1978 through November 1987 were reviewed. Early in the series all patients had a Stamm gastrostomy placed. As experience with percutaneous endoscopic gastrostomy increased, most patients received a percutaneous endoscopic gastrostomy. No randomization was performed. Patients with acute peritonitis, delayed gastric

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emptying, significant esophageal reflux, or cirrhosis with portal hypertension, ascites, or esophageal or gastric varices, were excluded. Prior abdominal surgery was not an exclusion factor unless the surgery had involved a partial or total gastrectomy.

The following standard technique was used for Stamm gastrostomy. A 6–8-cm midline incision was placed and a 22–28 F Silastic Malecot gastrostomy tube inserted high on the anterior gastric wall using 2–3 concentric purse string silk sutures to invaginate the gastric wall about the tube. The tube was brought out a separate stab wound in the left upper quadrant and the stomach was sewn to the abdominal wall at the tube exit site. The midline incision was closed primarily. The tube was connected to straight drainage. When drainage was minimal and bowel sounds were normal, the tube was clamped and bolus gastric feedings begun.

Percutaneous endoscopic gastrostomies were placed using a modification of the technique of Gauderer et al.³ Patients were given 10 mg of diazepam as a preoperative sedative when necessary and 1 g of cefazolin on call to the operating room. The abdomen was prepared for surgery with povidone-iodine soap, alcohol, and povidone-iodine solution and draped in a sterile fashion. A pediatric gastroscope was introduced into the stomach, carefully observing the esophageal lumen during passage to assure no strictures or other abnormalities. The stomach and pylorus were also examined to rule out the presence of varices or stricture. The stomach was insufflated with air through the gastroscope until it was fully distended. The light of the scope was directed anteriorly and the lights in the operating room dimmed, allowing visualization of the light through the abdominal wall. The presence of a sharp, circular light image assured that there was no intervening bowel or liver between the stomach and the anterior abdominal wall. The point of maximal light transillumination was selected for the gastrostomy site and was usually about one third of the distance along a line from the left costal margin at the midclavicular line to the umbilicus. Care was taken to always place the exit site at least 4 cm from the costal margin to avoid site irritation. If necessary, the site was adjusted so that palpation with a single finger at the site was clearly seen by the endoscopist as an indentation of the anterior stomach wall confirming apposition of the stomach to the abdominal wall. Occasionally in obese patients or patients with scarred abdominal walls as with prior burns, the light did not transilluminate. In all cases, however, palpation resulted in a clear indentation of the stomach wall and the procedure was continued. If neither sign is present, the procedure should be abandoned. The skin at the selected exit site was infiltrated with 1% Xylocaine® and an incision exactly 1.5 times wider than the diameter of the gastrostomy tube was

placed. A larger incision is associated with poor healing, skin irritation and, occasionally, tube erosion. A smaller incision drains poorly and leads to cellulitis at the exit site and occasionally a subcutaneous abscess or fasciitis. A 16-gauge Argyle Medicut “R” catheter was introduced through the incision and advanced into the stomach directing the tip toward the endoscope light (Sherwood Medical Industries, St. Louis, MO). A snare was passed through the endoscope and placed over the end of the Medicut catheter. A #1 nylon suture was passed through the catheter and grasped with the snare. The endoscope and suture were then drawn out through the esophagus and mouth. The Medicut catheter was removed from the abdominal wall and the end of the suture exiting from the mouth tied to the end of a 16 F Glasser Percutaneous Endoscopic Gastrostomy Tube (Biosearch Medical Products, Inc., Sommerville, NJ). The gastrostomy tube was marked with a marking pen at 1-cm intervals from its end for a distance of 4 cm (Fig. 1). The suture material and gastrostomy tube were then lubricated with Neosporin ointment™ (Burroughs Wellcome) and the suture withdrawn from the abdominal wall drawing the gastrostomy tube through the mouth, down the esophagus and out the abdominal wall. The tube was withdrawn until the inner disk retainer drew the stomach tightly against the abdominal wall and an appropriate number of markings for the estimated abdominal wall thickness were seen. The use of markings on the gastrostomy tube permitted omission of the second endoscopic procedure initially proposed by Gauderer et al.³ to assure the tube was tight against the gastric wall. Eliminating the second endoscopic procedure reduces risks of aspiration and esophageal injury. The outer retainer disk was then slid over the gastrostomy tube and secured tightly against the skin to maintain apposition of the stomach to the abdominal wall. The end of the gastrostomy tube was cut to proper length, an adaptor placed, and the tubing connected to straight drainage. Patients were returned to their hospital beds without going to the recovery room. They were given 1 g of cefazolin every 8 hours for two doses. The PEG tube was connected to straight drainage. When drainage was minimal and bowel sounds were normal, the tube was clamped and bolus gastric feedings were begun. At 48 hours the dressing was removed from the catheter site and the outer disk loosened to avoid erosion of the stomach or skin.

Operating room time from patient entry until departure was recorded along with the recovery room charges, material costs, and professional fees. Patients were followed for 96 ± 164 days (PEG) and 237 ± 392 days (Stamm) to determine the time until use for feeding and the incidence of complications. Statistical analysis was by Student's t-test and chi square analysis.

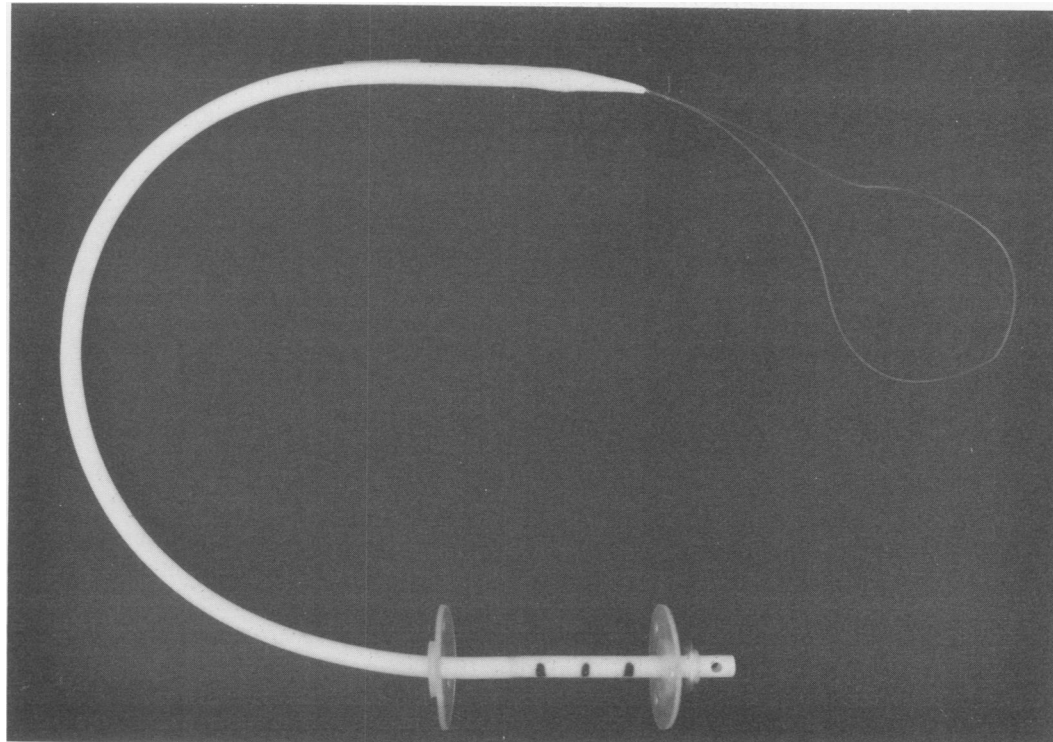


FIG. 1. Percutaneous gastrostomy tube. Note markings at end allowing estimation of distance of stomach from abdominal wall during placement. These markings allow placement by single endoscopy technique.

Results

From July 1981 through November 1987, 125 patients had percutaneous endoscopic gastrostomy tubes placed. In only two cases was the procedure abandoned because endoscopy could not be done. Experience in these patients was compared with 88 Stamm gastrostomies placed from November 1978 through November 1987. Table 1 compares population characteristics. The major indication for gastrostomy placement was altered mental status due to cerebral vascular accidents, primary neurological diseases, and head trauma (64%). Thirty-six per cent had difficulty swallowing due to head and neck tumors or their treatment. The average ASA anesthetic risk for PEG was 3.4 and for Stamm was 3.1 (NS) reflecting multiple other medical problems (Tables 1 and 2). The preference for percutaneously placed gastrostomy tubes later in the series is evident from 1986 and 1987 data that indicated 98 PEG but only 12 Stamm gastrostomies were placed.

The average operating room time required to place a percutaneous endoscopic gastrostomy was 50 ± 20 minutes compared with that for Stamm gastrostomy of 96 ± 26 minutes ($p < 0.0001$). There was a reduction in time for placement of percutaneous endoscopic gastrostomies as experience and expertise increased with an average time of 38 ± 14 minutes for the last 62 tubes placed in 1987. The reduced operating room time for PEG and little need for the recovery room resulted in a savings compared with Stamm gastrostomy of almost

\$1000 per case. Only 16 percutaneous endoscopic gastrostomies (13%) were done under general anesthesia. Of those, most received general anesthesia either because of other procedures performed simultaneously or for patient comfort in the presence of a tracheostomy. On the other hand, it was elected to perform 57 Stamm gastrostomies (64%) under general anesthesia due to poor abdominal relaxation or patient cooperation. The average time until use of percutaneous endoscopic gastrostomy tubes for enteral feeding, 1.8 ± 0.8 days, was less than that for Stamm gastrostomy tubes, 3.4 ± 2.0 days ($p < 0.0001$). Days to discharge were highly variable (PEG = 55 ± 123 days vs. Stamm 26 ± 40 days, $p = 0.117$) and were determined by the patients' primary illness rather than the type of gastrostomy.

Complications after percutaneous endoscopic gastrostomy occurred in 8.8% of patients (Table 3). Two aspiration pneumonias occurred owing to endoscopy, both of which resolved with antibiotics. The one episode of gastric hemorrhage was minor, resolving spontaneously without transfusion. Four of the six episodes of gastrostomy tube exit site infections were minor. Two had significant cellulitis and required antibiotic therapy and drainage. Most exit site infections occurred early in the series and were due to a small skin incision with inadequate drainage about the tube. Only one exit site infection has occurred in the past 98 placements after incisions measuring 1.5 times the diameter of the gastrostomy tube were routinely used and perioperative antibiotics were given. One feeding tube was dislodged by a

TABLE 1. Patient Characteristics

	PEG	Stamm	p Value
Number in study	125	88	—
Age \pm SD	62 \pm 17	58 \pm 17	NS
Sex M/F	75/50	52/36	NS
Ave ASA	3.4	3.1	NS
Reason for tube			
Altered mental state	88	43	0.02
Swallow difficulty	37	45	
ASA grade			
Level <2	5	4	
Level 3	71	55	NS
Level 4	44	29	
Level 5	5	0	

confused patient during the first postoperative night. The patient was taken to the operating room immediately and had a Stamm gastrostomy placed. One tube had transient leakage of gastric juice about it. Five tubes were removed when no longer needed without difficulty. No gastrocutaneous fistula developed.

Thirty-one patients had percutaneous endoscopic gastrostomy tubes placed after prior upper (17 patients) and lower abdominal procedures (14 patients) (Table 4). In each case the endoscope light was clearly visualized through the abdominal wall and indentation of the stomach with external pressure at the exit site was clearly visualized. Three morbidly obese patients underwent PEG. Although no light transillumination was seen, palpation was seen to indent the anterior stomach wall. No operative complications were seen in any of these patients.

Complications after placement of Stamm gastrostomies occurred in 23.9% of patients (Table 5). This incidence was significantly higher than for PEG ($p < 0.005$). Seven wound infections occurred requiring partial (3) or complete (4) opening of the wound for debridement and packing. Four instances of tube exit site infections resulted in significant skin erosion and leakage of gastric contents. Intensive local wound care and insertion of a larger tube was required. Leakage of gastric juice at the tube exit site occurred in four additional patients. In one patient it could not be controlled and the gastrostomy

TABLE 2. Other Medical Problems Resulting in Increased Anesthetic Risks

Problem	% Patients	
	PEG	Stamm
Cardiac disease (MI, HTN, arrhythmias)	42	23
Pulmonary disease (pneumonia, failure)	40	38
AODM, renal failure	17	13
Other	8	9

TABLE 3. Complications of PEG Duke Series of 125 Patients

2	Aspiration pneumonias from endoscopy
0	Esophageal laceration/perforation
1	Hemorrhage at gastrostomy site (minor)
0	Peritonitis
1	Leakage at gastrostomy site
6	Exit site infections (4 minor)
1	Tube withdrawal from stomach
0	Colonic perforation, gastrocolic fistula
0	Gastrocutaneous fistula after tube is out
11	Overall 8.8% Major 4.0%

tube was removed and replaced with another done by percutaneous endoscopic technique. The old gastrostomy site did not heal and was finally closed surgically. One patient had transient bleeding from the stomach and one patient had the tube withdrawn at postoperative day 3. The tube was successfully replaced under fluoroscopic guidance. Two patients had severe pain at the gastrostomy site and required intermittent use of narcotic analgesics. One patient had gastric outlet obstruction from the tip of the gastrostomy tube lodging in the pylorus.

Eventual outcome of all patients is depicted in Table 6. No patient died in this series as a complication of placement of the feeding gastrostomy. The high death rate (30.0%) relates to the severity of illness of these patients.

Discussion

Previous reports have documented reduction in operating room time and cost when percutaneous endoscopic gastrostomies are performed compared with standard gastrostomies by laparotomy.^{1,6-9} The reduction in total operating room time and little need for the recovery room in this series reduced patient charges by

TABLE 4. Prior Abdominal Operations in Patients Undergoing Gastrostomy

Procedure	No. of Patients	
	PEG	Stamm
Upper		
Repair abdominal aortic aneurysm	2	2
Cholecystectomy	7	8
Perforated duodenal ulcer	1	1
Small bowel resection	0	4
Colon resection	0	6
Lysis of adhesions	0	4
Ventriculoperitoneal shunt	5	0
Previous gastrostomy	2	0
Lower		
Appendectomy	7	6
Hysterectomy	6	6
Cesarian section	1	0

TABLE 5. *Complications of Stamm Gastrostomy Duke Series of 88 Patients*

7	Wound infections	
4	Exit site infections	
1	Hemorrhage at gastrostomy site	
4	Leakage at gastrostomy site	
1	Tube withdrawal from stomach	
2	Pain at tube exit site	
1	Pyloric obstruction by tube	
1	Gastrocutaneous fistula after tube out	
21	Overall 23.9%	Major 10.2%

about \$1000. The actual endoscopic procedure takes only 10–15 minutes with the remainder of the 30–40 minutes required for patient transfer and establishment of monitoring and intravenous access.

Some physicians advocate placement of percutaneous gastrostomy tubes in the endoscopy suite rather than in the operating room. In selected patients this may be appropriate and would further reduce costs. Most of our patients, however, had significant medical illnesses including poor pulmonary toilet, hypertension, and cardiac disease, and it was believed that for optimal safety the operating room environment was required where airway management could be easily performed and cardiac arrhythmias and arterial oxygen saturation monitored and quickly addressed if necessary. In four of our patients, arterial oxygen saturation by pulse oximeter fell below 90% during endoscopy but was easily treated by adjusting the position of the head, oral suctioning, or administering supplemental oxygen. Oxygen desaturation may go unnoticed in an endoscopy suite possibly contributing to pre-existing altered mental status. The reduced surgical trauma of PEG resulted in a significant decrease in postoperative gastrointestinal ileus allowing earlier institution of gastric feeding. Although abdominal distention due to insufflation of air was common, bowel sounds were usually present within 24 hours of PEG placement and the gas passed through quickly. Abdominal x-rays were not routinely done after PEG placement but when done there was no evidence for pneumoperitoneum.

Only two operative complications of PEG were encountered in this study, both aspiration pneumonias. One possible advantage of the single endoscopic method described herein is the avoidance of potential complica-

tions associated with passage of the endoscope a second time to confirm proper tension on the gastrostomy tube. Manufacturers of commercially available percutaneous endoscopy tubes have yet to permanently mark their catheters; however, sterile marking pens provide a satisfactory alternative.

A list of potential complications associated with percutaneous gastrostomy placement (Table 3) suggests to this author that the procedure should be performed by surgeons rather than gastrointestinal endoscopists. Most complications require surgical management and would be most quickly recognized and expeditiously handled by the surgeon.

The safety of placing percutaneous endoscopic gastrostomy tubes in the presence of prior abdominal surgery, suggested by Stellato et al.,¹⁰ is supported by this series. As long as the endoscope light clearly transilluminates through the abdominal wall and/or external pressure at the proposed gastrostomy exit site results in clear indentation of the gastric wall as seen through the endoscope, preferably both, it is safe to proceed without fear of passage through either the liver or interposed bowel.

Conclusions

Percutaneous endoscopic gastrostomy reduces operative time, necessity for general anesthesia, expense of gastrostomy placement, incidence of complications, and requires less recovery time before use for enteral feedings. This study supports the use of percutaneous endoscopic gastrostomy as the procedure of choice for gastric feeding access even in patients with prior abdominal surgery. Stamm gastrostomies should be placed when a laparotomy is performed for other reasons or when gastroscopy is not possible or advisable.

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TABLE 6. *Eventual Outcome of Patients*

	PEG	Stamm
Tube removed, oral diet	7	16
Died	31	33
Lost to follow-up	51	33
Continued follow-up, tube OK	36	6

patients with percutaneous endoscopic gastrostomy or surgical Stamm gastrostomy (Abstract). *Gastrointest Endosc* 1986; 32:147.

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DISCUSSION

DR. NORMAN HALPERN (Birmingham, Alabama): With any new technique or technology we should ask two questions.

Will it perform a new or different task, or will it better perform an old task? In this case there is nothing really new or different about creating a tube gastrostomy. On the other hand, I am personally convinced that this is a totally superior method for getting the job done.

My experience with 63 patients at UAB is similar to Dr. Grant's larger, carefully reviewed series. I appreciated having a copy of his manuscript and agree with all of his cautions regarding careful assessment of indications and contra-indications, thoughtful attention to the matter of patient safety and monitoring, and to the technical details of the procedure.

An additional application of endoscopic gastrostomy occurred in three of my patients and has been reported by others. That is, for the patient with intra-abdominal carcinomatosis having had repeated episodes of small bowel obstruction and felt to have an unlikely chance of benefit from further surgery. Enteric decompression combined with home parenteral nutrition achieved excellent palliation for periods of 1, 6, and nearly 8 months in these three patients.

I do appreciate the chance to comment and offer support for a procedure that I think really does offer improvement in patient care.

DR. HENRY L. LAWS (Birmingham, Alabama): It appears that Dr. Halpern and I almost have to go as a team.

I think Dr. Grant is to be commended for his critical evaluation of the data on a large number of gastrostomies. From what we heard this morning, this topic is very appropriate, since the first paper given 100 years ago was on gastrostomy.

It is actually disconcerting to me that we are still trying to perfect the operation.

I feel this lowly operation does not receive the attention it deserves. I would differ with Dr. Grant and with my colleague, Dr. Halpern, to some extent in that I think the stapled Janeway gastrostomies are superior to Stamm gastrostomies over the long haul.^{1,2}

(Slide) This series was collected by Dr. Fred Swartzendruber, one of our colleagues. What it indicates is that the late complications of Stamm gastrostomies, of which I feel the percutaneous endoscopic gastrostomy is a variant, include late tube malfunction, exit site problems, and so forth, which can be very trying. Neither of these are lined with mucosa. On the other hand, the problems we had with Janeway gastrostomy were very minimal and were minor in every instance.

I would like to ask Dr. Grant how long he followed his patients and how they have been faring over the long haul.

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DR. LEWIS M. FLINT, JR. (Buffalo, New York): I would like to address the use of feeding gastrostomy in a select group of neurologically disabled patients, those who are comatose or obtunded, and to raise the question of whether this operation, regardless of the technique, is indicated and whether it achieves the objectives that we wish it to achieve in the long term.

We recently reviewed 87 comatose or severely obtunded patients in our unit in which feeding gastrostomy was performed for two basic indications, for example, to provide access for nutritional support and, in some cases, to reduce the risk of aspiration pneumonia.

We found that the operation did not, over a two-year follow-up, achieve either objective and that not only was the risk of aspiration pneumonia that existed pregastrostomy not reduced, but about 30% of those patients in whom no aspiration pneumonia could be documented preoperatively developed it postoperatively over the two-year period.

The one-year mortality in our group was 34%, most of this as a result of aspiration pneumonia.

According to our clinical experience, then, gastrostomy did not achieve the objective of reducing the risk of aspiration pneumonia. Neither did it achieve the objective of providing nutritional support, since we could not document nutritional benefit in a single one of our patients in this particular group.

Since we can now acquire and maintain enteral access by the transnasal soft tube technique, using the transpyloric tubes in better than 95% of the patients, I would ask Dr. Grant to comment on the indications, particularly in this select group of patients, and ask him two additional questions. Was the objective of gastrostomy achieved, long-term? And in patients with aspiration pneumonia, does he consider the addition of complementary tracheostomy?

DR. JOHN P. GRANT (Closing discussion): Dr. Halpern has employed percutaneous gastrostomies in a population in which we have little experience: those patients who have distal bowel obstruction and require gastric decompression. I recall several cases where I have placed a Stamm gastrostomy during laparotomy when a diagnosis of carcinomatosis was made to establish proximal decompression. I have been rather disappointed with the clinical benefits, most of the patients dying rather quickly after the operative procedure, and I congratulate Dr. Halpern on his more favorable results.

Dr. Laws, we have very little experience with the Janeway gastrostomy. It is interesting to hear that you feel it is superior to the Stamm gastrostomy.

We have followed our patients on the average for 100 days after percutaneous gastrostomy, and about 200 days after the Stamm gastrostomy. As many patients have gone to distant hospitals or nursing homes, accurate follow-up has been difficult, as you might expect. We know at least 20% have died from their primary disease process. We know another 12% have improved and their feeding tubes have been removed. The remainder have been lost to follow-up after they left the hospital.

Dr. Flint, gastrostomies, I think, are always going to be associated with aspiration pneumonia. It is a complication that is very difficult to avoid in a patient who is not very alert and who is often reclining at the time of feeding, as well as between feedings. It is therefore difficult to distinguish aspiration of tube feedings from aspiration of saliva in patients who have difficulty swallowing. We have had great difficulty sending patients to nursing homes with either a nasojejunal feeding tube or with a feeding jejunostomy. It requires a level of care that they are unprepared (and often unwilling) to assume. In patients who have had repeated bouts of aspiration pneumonia in the hospital, however, I have elected on occasion to place both a gastrostomy for decompression and jejunostomy for feeding, and have been pleased with the results. Another approach that several of our surgeons have taken is to perform both a Stamm gastrostomy and a Nissen fundoplication simultaneously, which, although it may not prevent aspiration of saliva, at least prevents the reflux.